

# Atmosphere

# Earth's atmosphere

- Earth's *atmosphere* is a layer of gases surrounding the planet.
- The Earth is surrounded by a blanket of air, which we call the atmosphere. It reaches over 560 kilometers from the surface of the Earth.

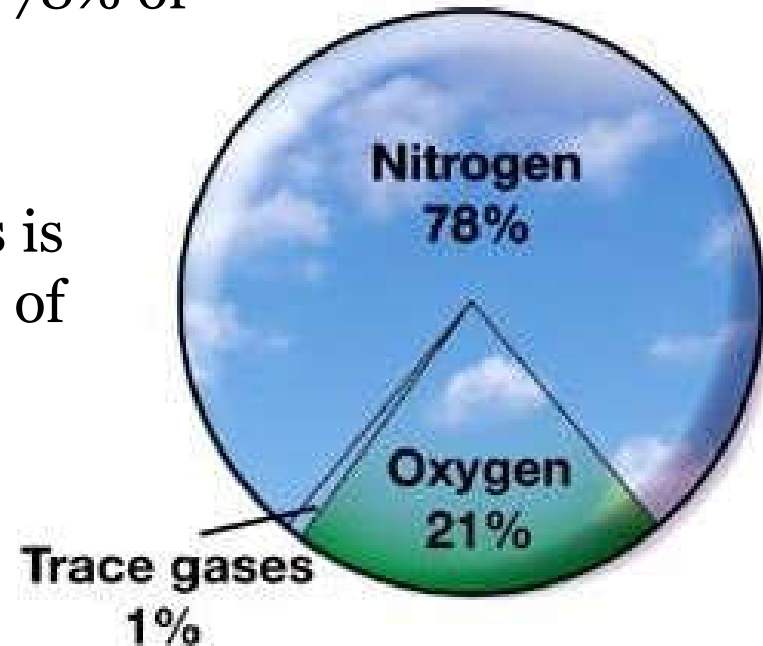


## Atmosphere:

- Absorbs the energy from the Sun,
- Recycles water and other chemicals,
- protects us from high-energy radiation and the frigid vacuum of space.
- The atmosphere protects and supports life.

# Earth's atmosphere

- Earth's atmosphere is made of a mixture of gases called **air**.
  - **Nitrogen** gas makes up about 78% of Earth's atmosphere.
  - The second most abundant gas is **oxygen**, which makes up 21% of Earth's atmosphere.
  - The third **Argon** (Ar, 0.9%).
  - **Carbon Dioxide** (CO<sub>2</sub>, 0.03%).



# Composition of the Atmosphere

The atmosphere is comprised of a variety of gases:

➤ **Major Constituents (99%):**

➤ Nitrogen (N): 78%

➤ Oxygen (O<sub>2</sub>): 21%

➤ **Trace Constituents:**

➤ Argon (Ar), about 0.9%

➤ Water vapor (H<sub>2</sub>O), up to 10000 ppmv

➤ Carbon dioxide (CO<sub>2</sub>), 350 ppmv

➤ Ozone (O<sub>3</sub>), near zero at the surface, up to 10 ppmv in the stratosphere

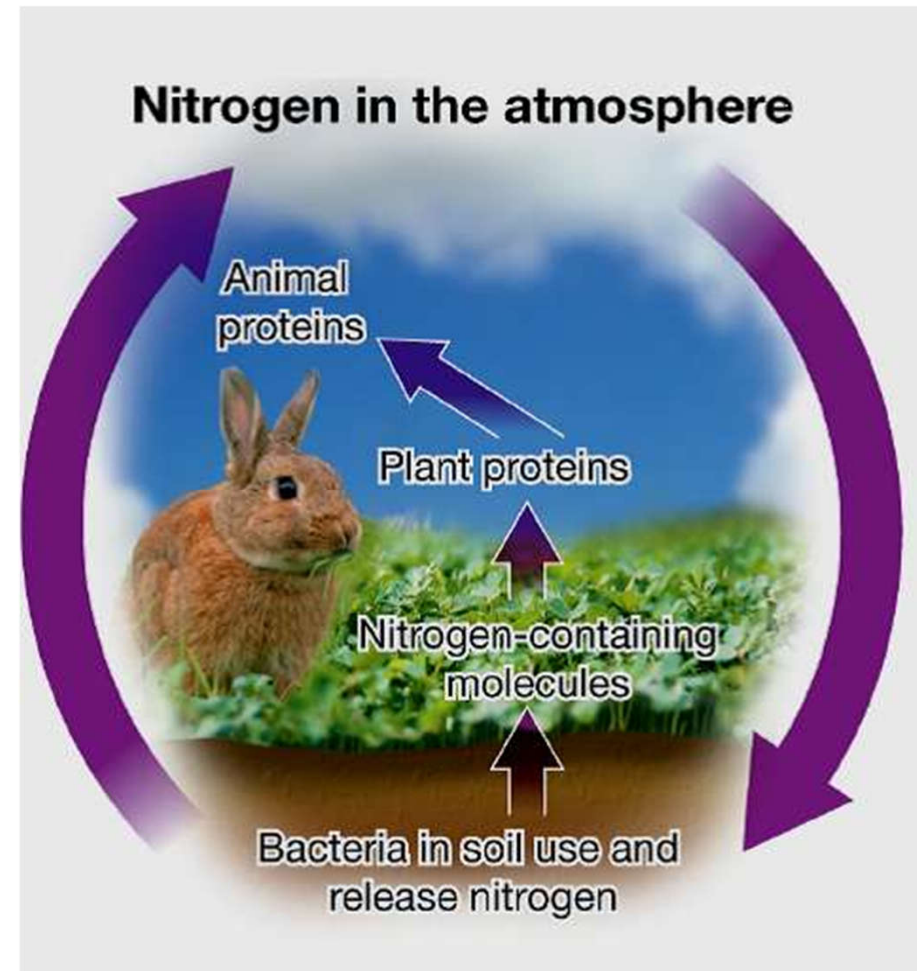
➤ Methane (CH<sub>4</sub>), 1.7 ppmv

➤ and others.....

ppmv = “parts per million by volume”

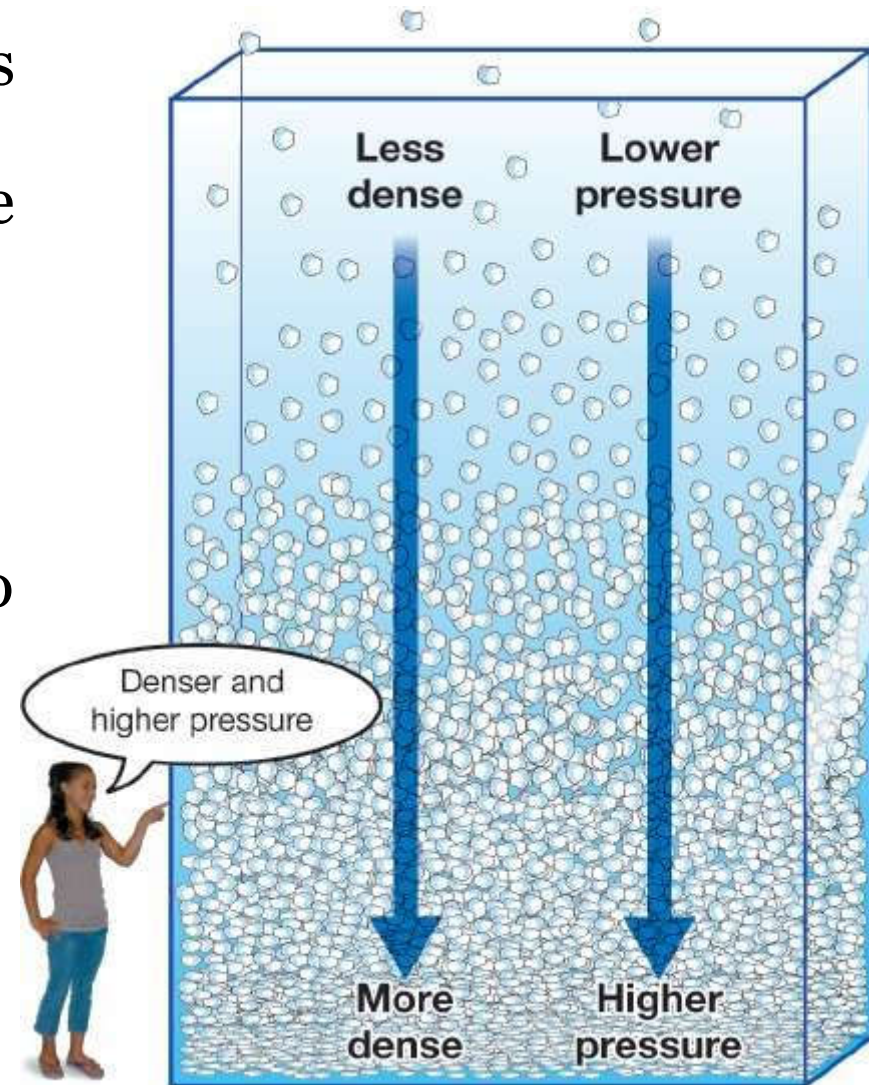
# Nitrogen Cycle

- Nitrogen is important to protein which is found in the body tissues of all living things.
- Nitrogen is cycled through the soil and into plants and finally when living things die and decay.



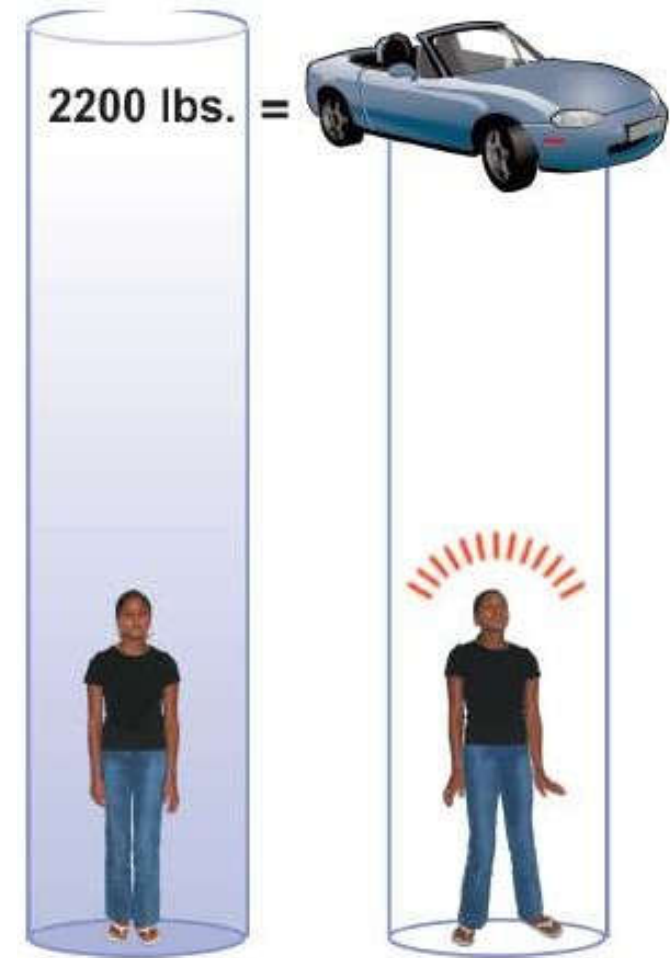
# Pressure in the atmosphere

- **Atmospheric pressure** is the force per unit area exerted into a surface by the weight of air above that surface in the atmosphere of Earth.
- The gas molecules closest to Earth's surface are packed together very closely.
- This means pressure is lower the higher up you go into the atmosphere.



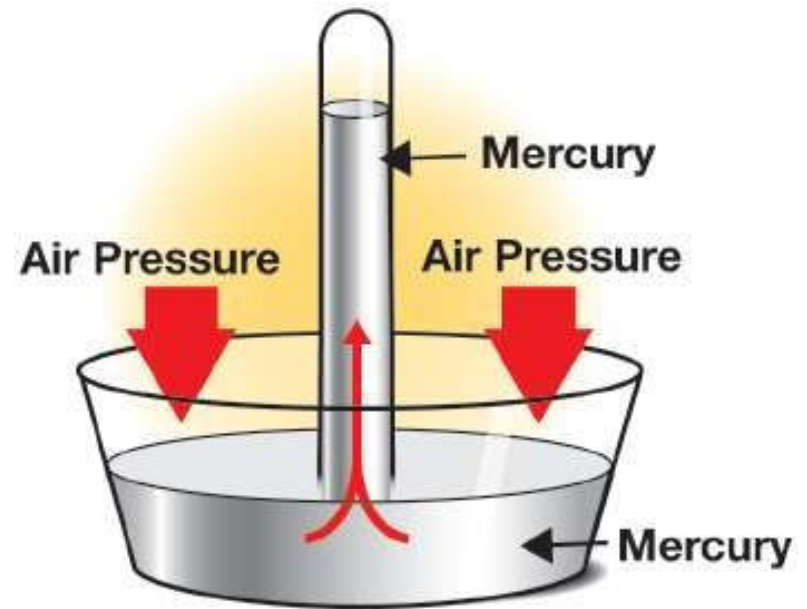
# Pressure in the atmosphere

- At sea level, the weight of the column of air above a person is about 9,800 Newtons (2,200 pounds)!
- This is equal to the weight of a small car.
- 1 atm = 14.69 pound/sq inch
- = 6.6 kg/ sq inch
- Other units of pressure are mm of Hg, millibar, pascal



# Measuring Pressure

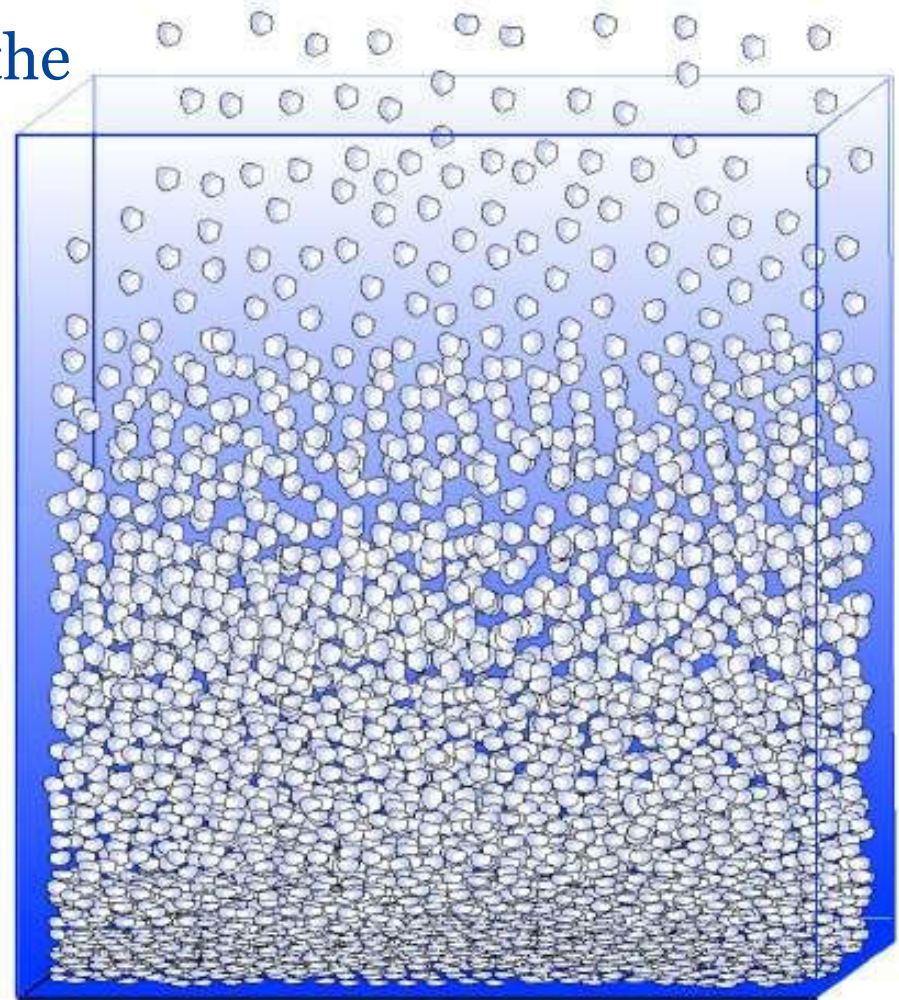
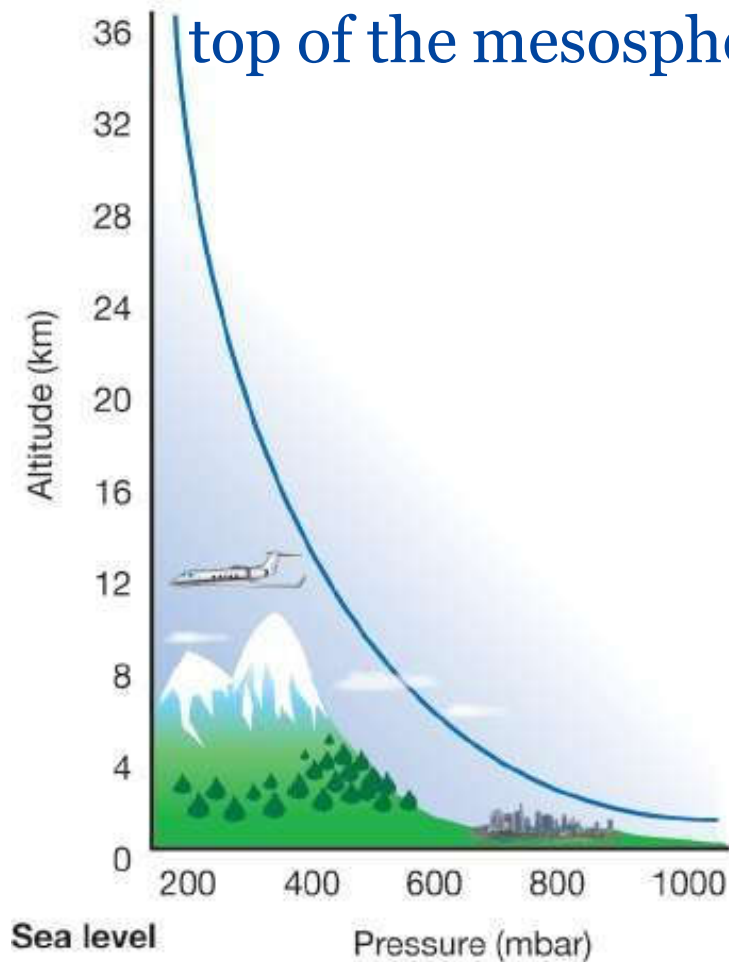
- A **barometer** is an instrument that measures atmospheric pressure.
- Long ago, mercury barometers were used
- Since mercury is a poisonous liquid, *aneroid barometers* are used today.





# Pressure changes with altitude

Pressure varies smoothly from the Earth's surface to the top of the mesosphere.

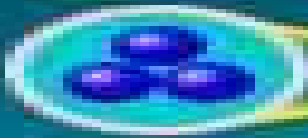


# Layers of Atmosphere

thermosphere

mesosphere

ozone



stratosphere

troposphere

# Layers of Atmosphere

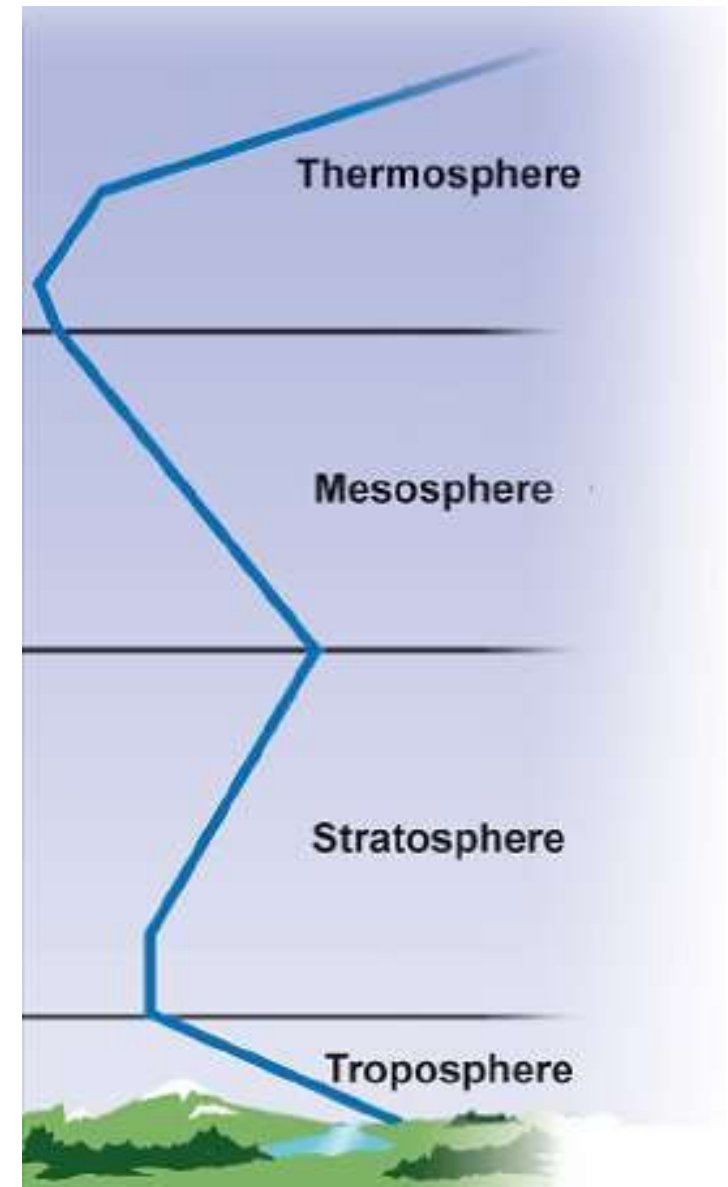
The atmosphere has four layers

➤ Thermosphere

➤ Mesosphere

➤ Stratosphere

➤ Troposphere



# Layers of Atmosphere

## *Troposphere*

- Lowest and thinnest layer
  - 16 km at equator, 8 km at poles
- 90% of the atmosphere's mass
- Temperature **decreases** with altitude
  - 6°C per kilometer
  - Top of troposphere averages  $-50^{\circ}\text{C}$
- Where weather occurs
- Boundary between the troposphere, and the stratosphere is called the **tropopause**

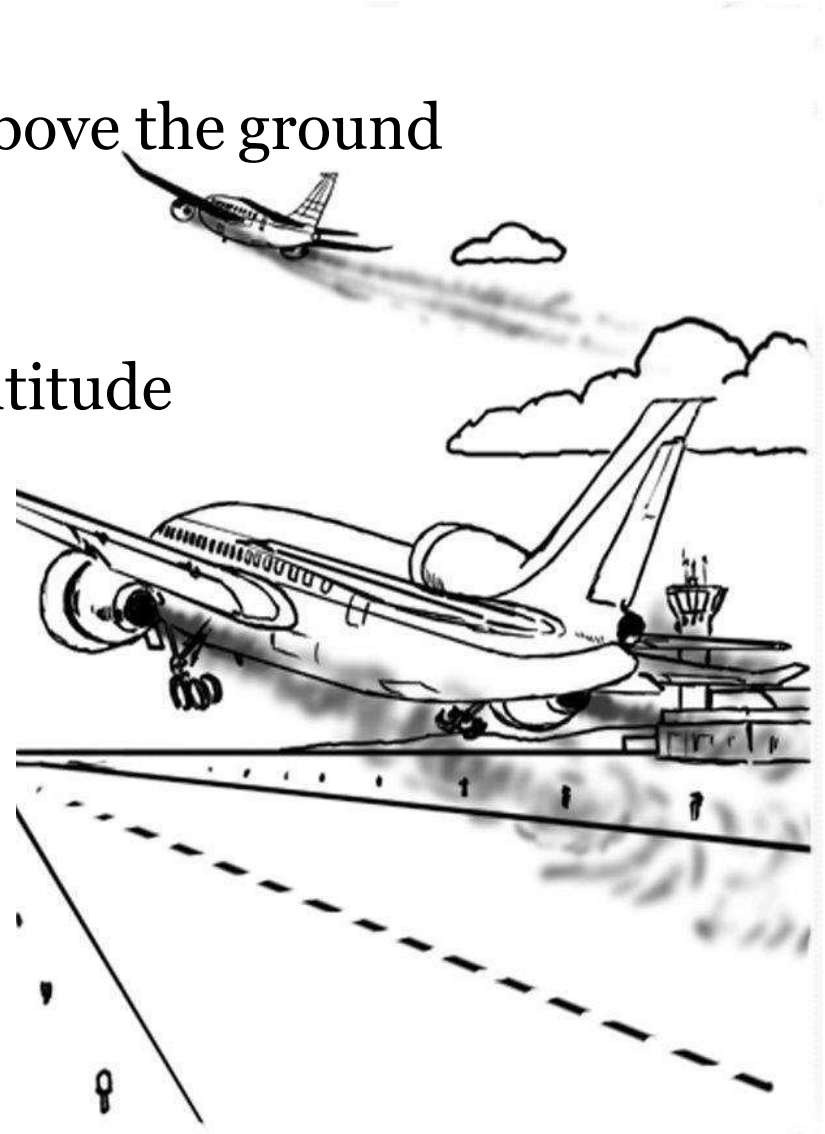


View of troposphere layer from an airplane's window.

# Layers of Atmosphere

## *Stratosphere*

- Extends from 10 km to 50 km above the ground
- Less dense (less water vapor)
- Temperature **increases** with altitude
- Almost no weather occurrence
- Contains high level of ozone
  - **Ozone layer**
- Upper boundary is called **stratopause**.



# Layers of Atmosphere

## *Mesosphere*

- Extends to almost 80 km high
- Gases are less dense.
- Temperature **decreases** as altitude increases.
  - Gases in this layer absorb very little UV radiation.



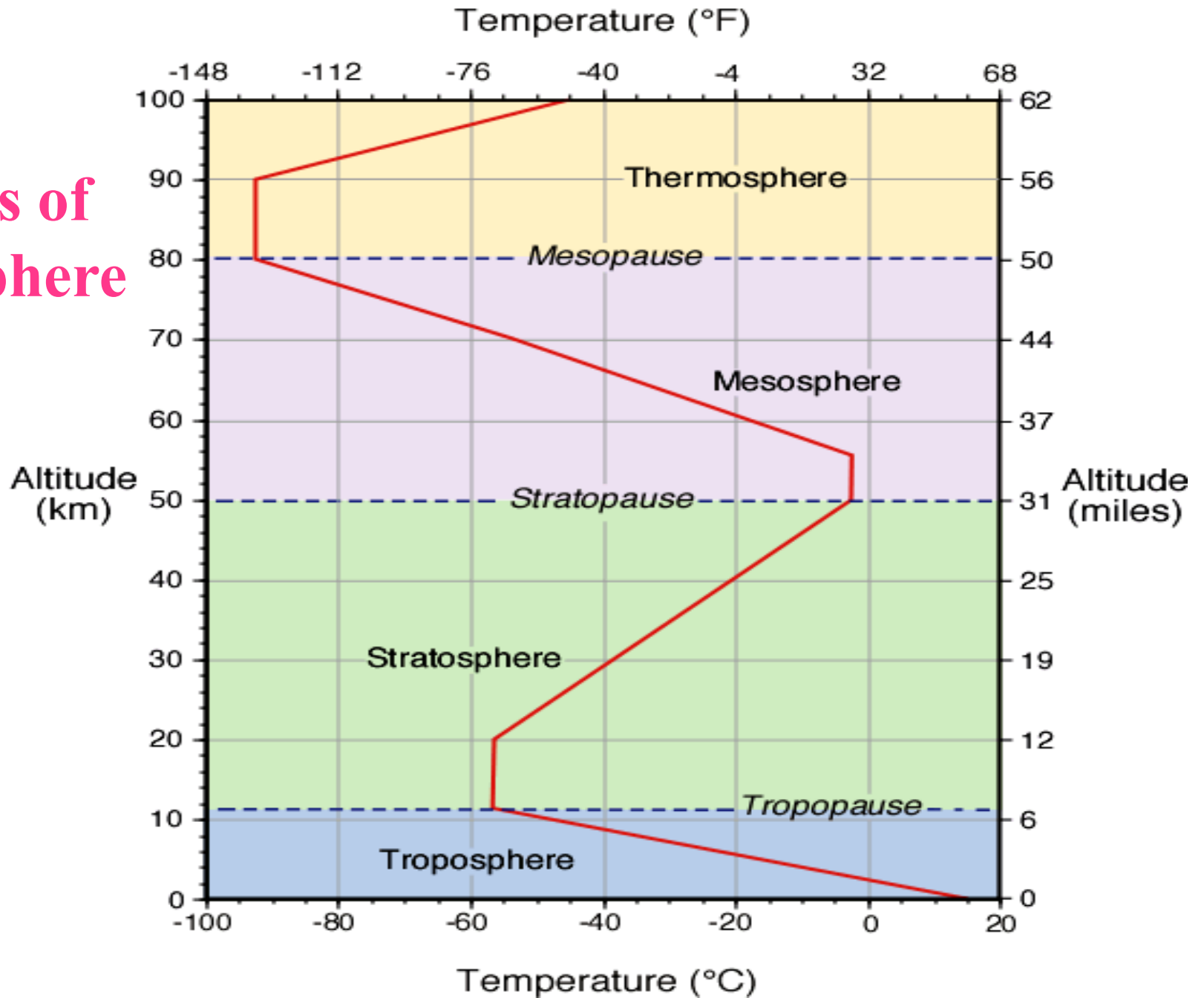
# Layers of Atmosphere

## *Thermosphere*

- Above the mesosphere and extends to almost 600 km high
- Temperature **increases** with altitude
- Readily absorbs solar radiation
- Temperature can go as high as 1,500 °C
- Reflects radio waves



# Layers of Atmosphere

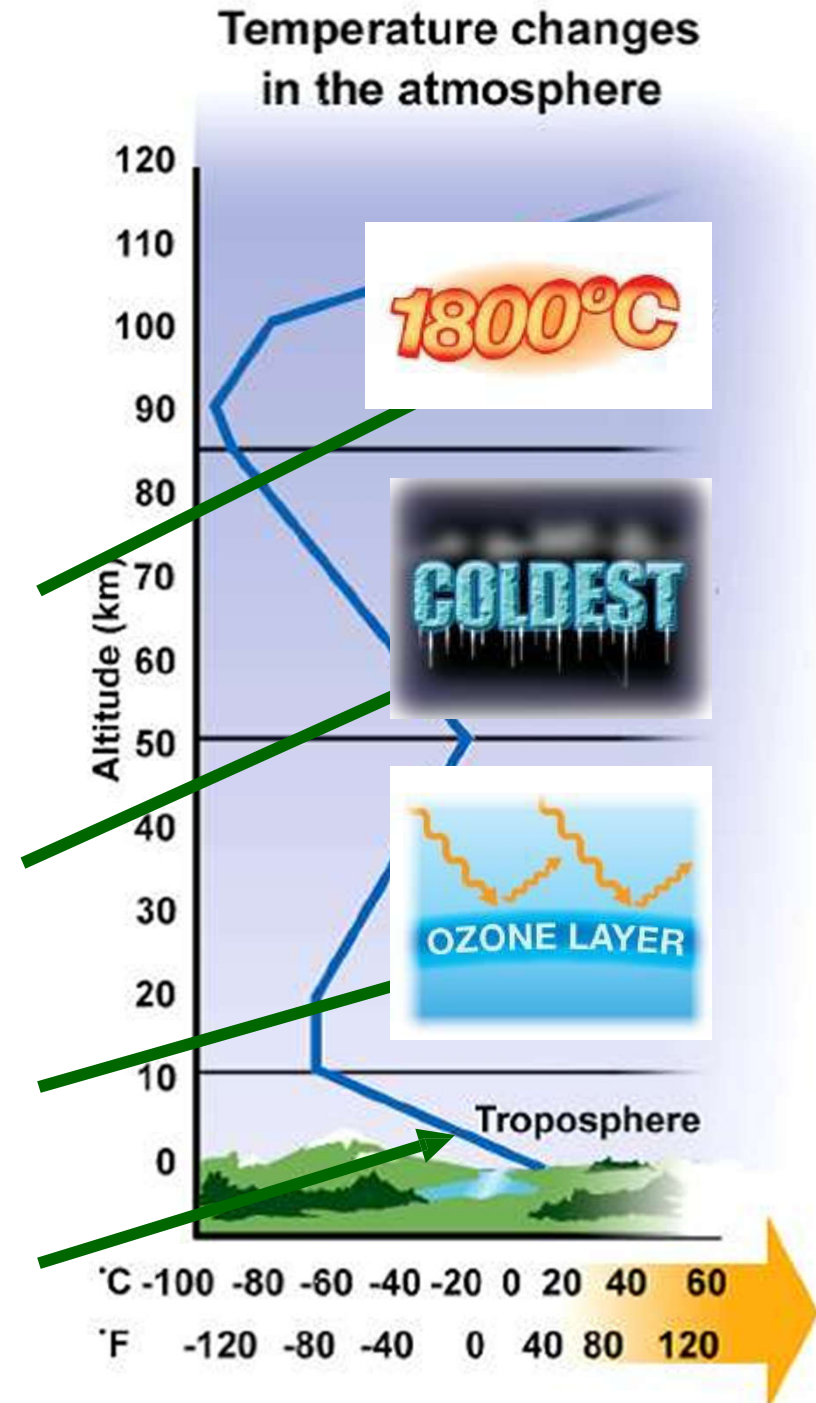




# Layers of the Atmosphere

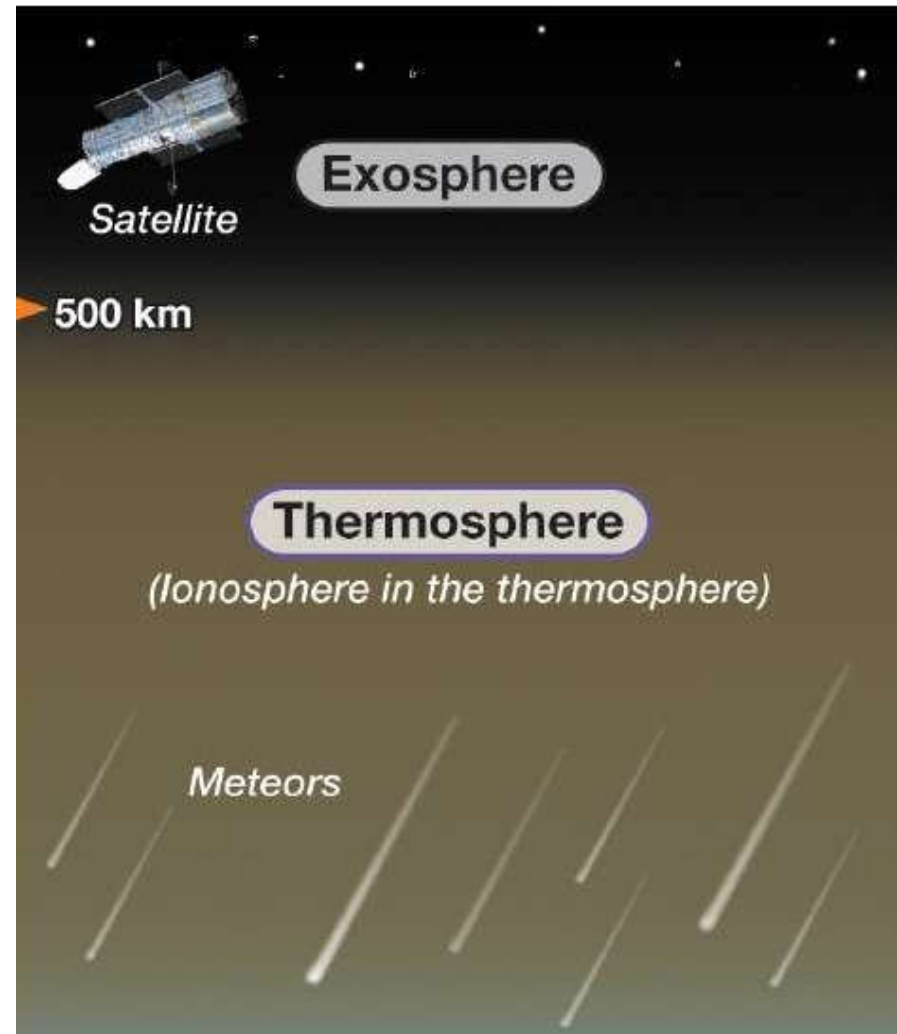
The four layers of the atmosphere include:

1. the *troposphere*, where we live;
2. the *stratosphere*, which contains the ozone layer;
3. the *mesosphere*, where meteors burn; and
4. the *thermosphere*, where satellites orbit Earth.



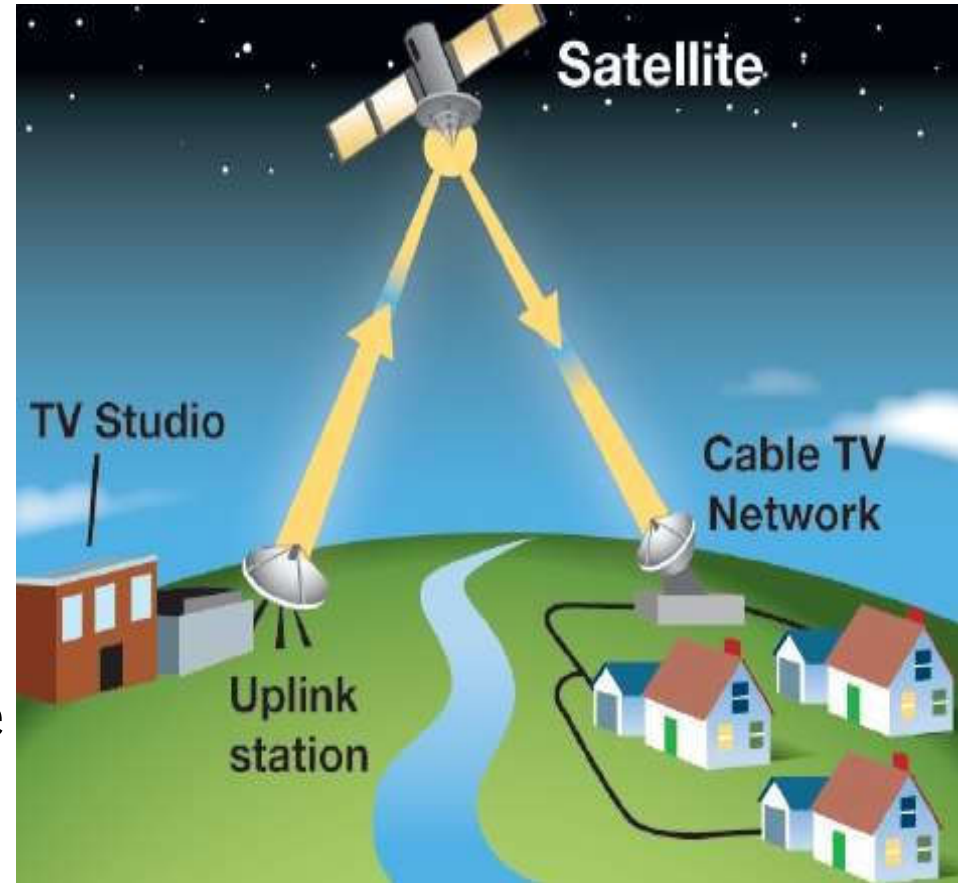
# Layers of the Atmosphere

- The **exosphere** begins at about 500 kilometers above Earth and does not have a specific outer limit.
- Satellites orbit Earth in the exosphere.



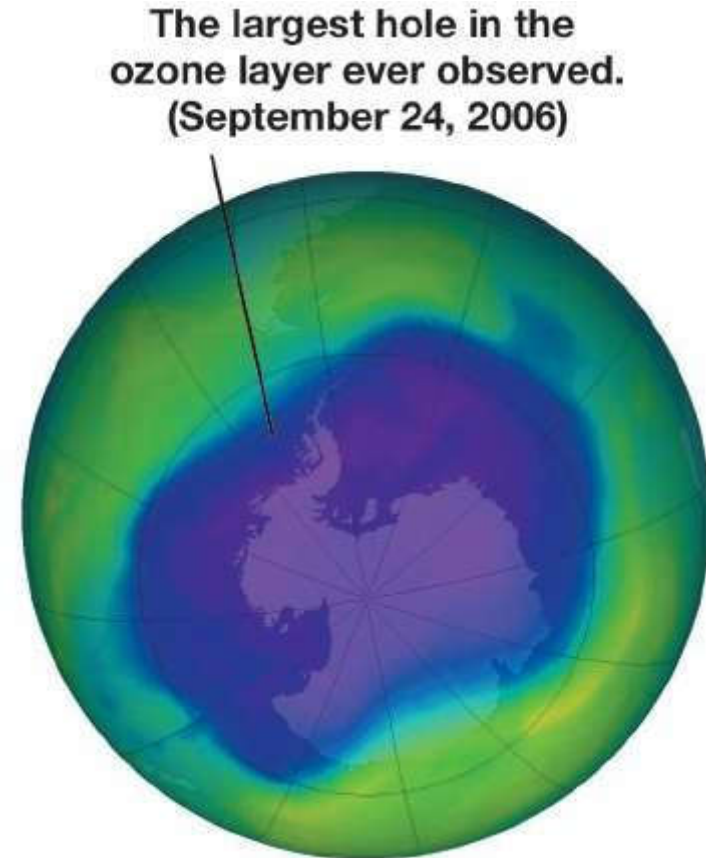
# The exosphere and ionosphere

- Communication on Earth depends on satellites.
- Satellites transmit information used for television shows, radio broadcasts, data and photos used in weather reports, and long distance telephone calls.



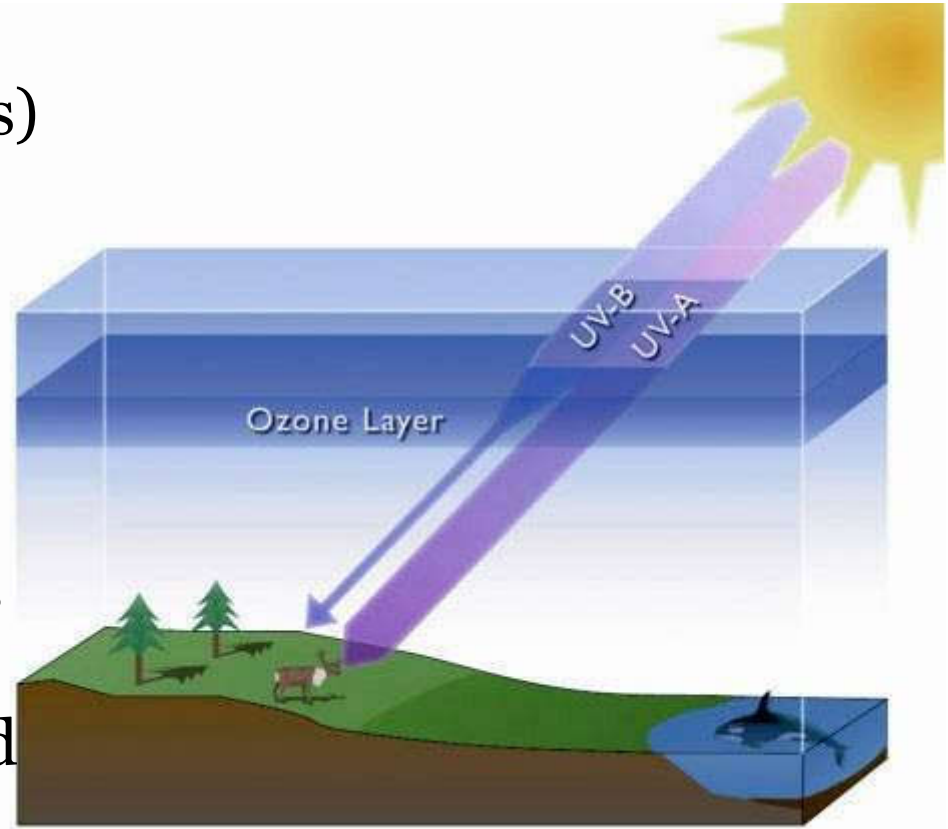
# The ozone layer

- In the 1970s, scientists noticed that the ozone layer in the stratosphere above Antarctica was thinning.



# Chlorofluorocarbons & the ozone layer

- A group of chemicals called chlorofluorocarbons (or CFCs) were once commonly used in air conditioners, in aerosol spray cans, and for cleaning machine parts.
- In the London Agreement of 1991, more than 90 countries banned the production and use of CFCs except for limited medical uses.

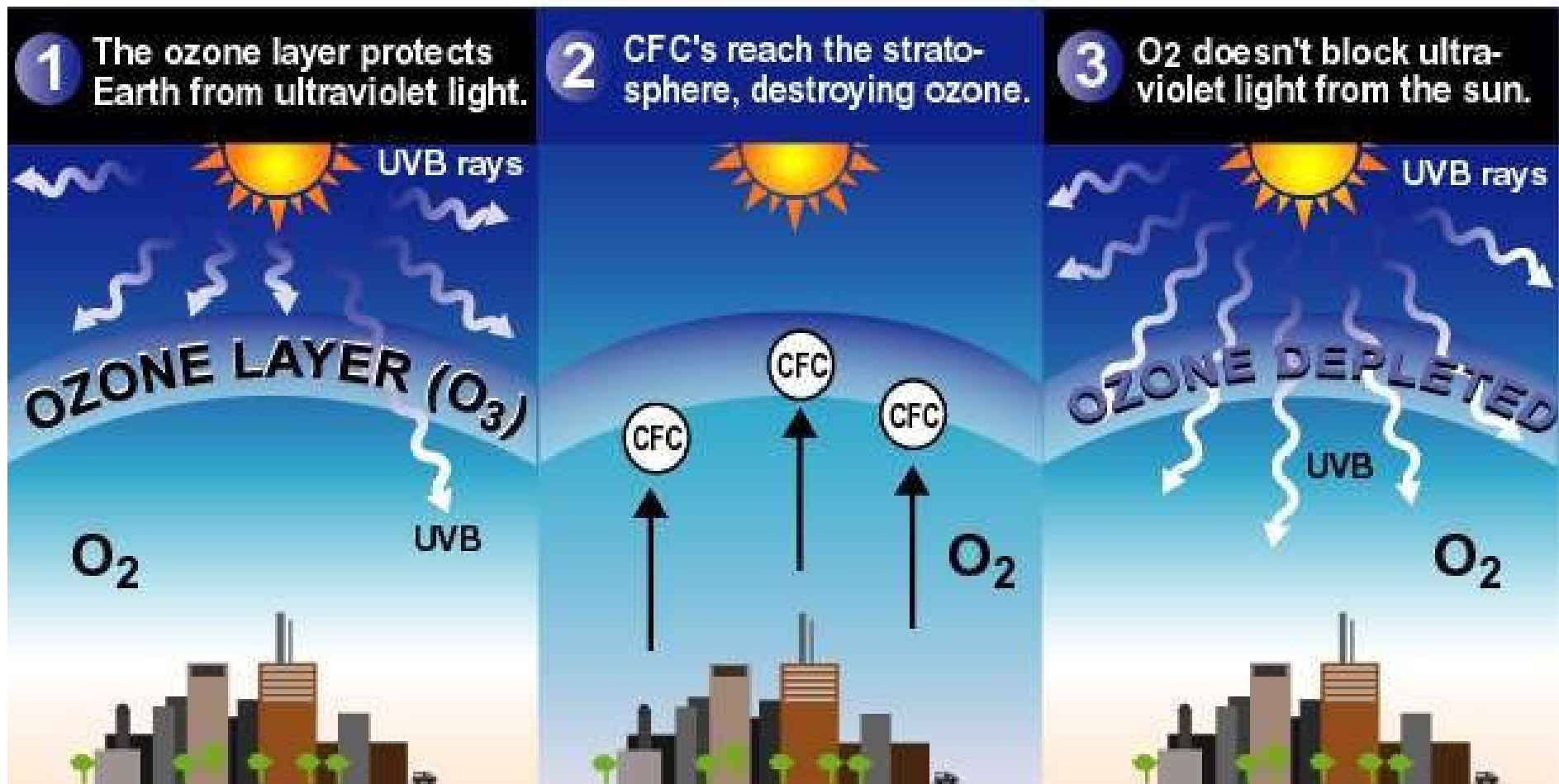


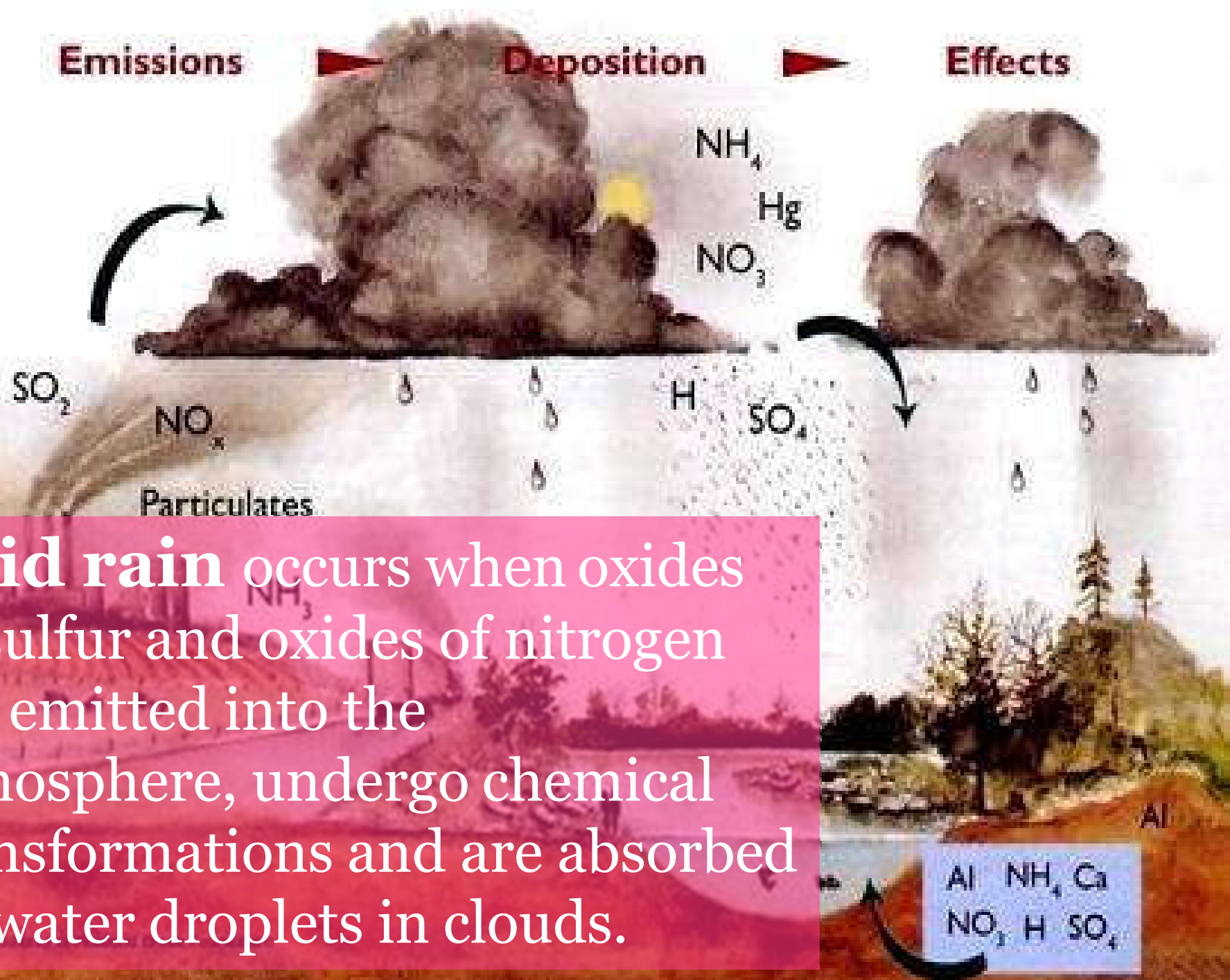
# Chlorofluorocarbons & the ozone layer

- The ozone layer absorbs the Sun's high-energy ultraviolet (UV) radiation and protects the Earth.
- In the stratosphere, the CFCs break down and release chlorine.
- The chlorine reacts with ozone molecules, which normally block incoming ultraviolet radiation.



# Chlorofluorocarbons (CFCs) and Ozone Depletion





**Acid rain** occurs when oxides of sulfur and oxides of nitrogen are emitted into the atmosphere, undergo chemical transformations and are absorbed by water droplets in clouds.



# Effects of Acid Rain

- Acidification of bodies of water
- Damage of vegetation
- Damage to building materials, statues, etc.



# GREENHOUSE EFFECT

The trapping of heat by gases in the atmosphere.

➤ **Naturally occurring greenhouse gases:**

- *Water vapor*
- *Carbon dioxide*
- *Methane*
- *Nitrous oxide*
- *Ozone*

➤ **Greenhouse gases that are **not** naturally occurring**

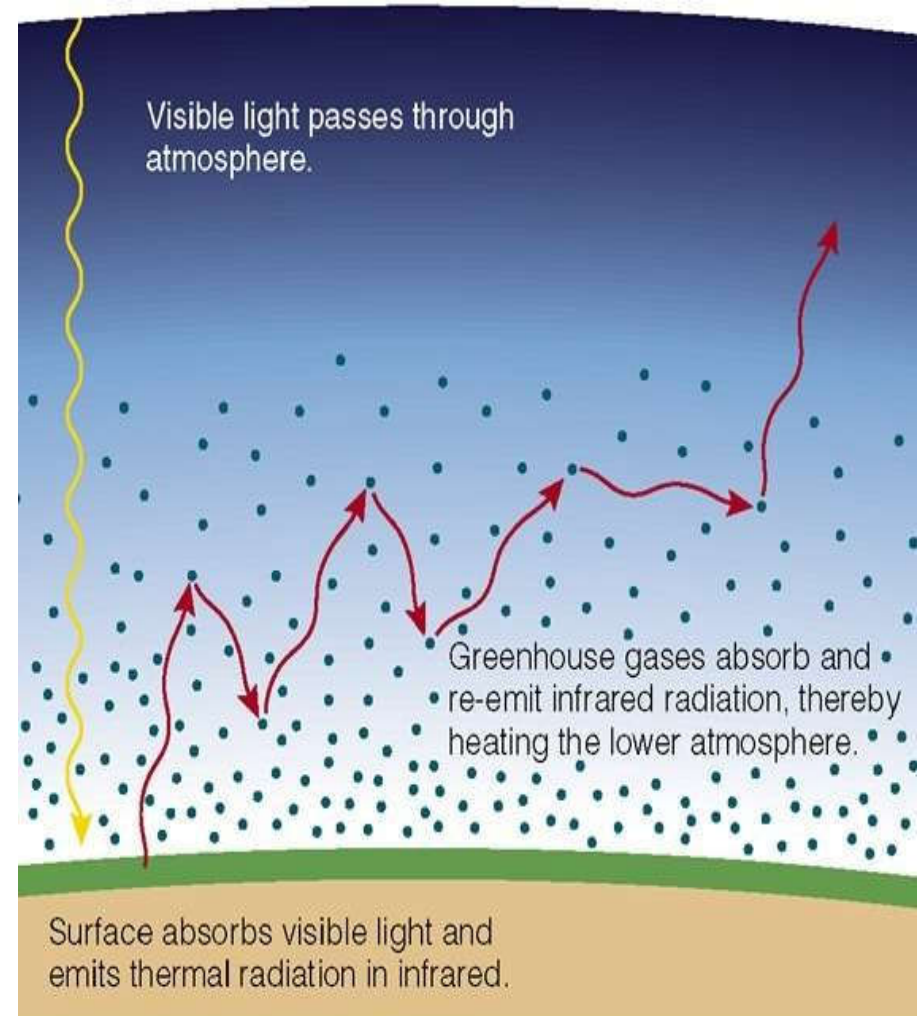
- *Hydro fluorocarbons* (HFCs)
- *Per fluorocarbons* (PFCs)
- *Sulfur hexafluoride* (SF<sub>6</sub>)

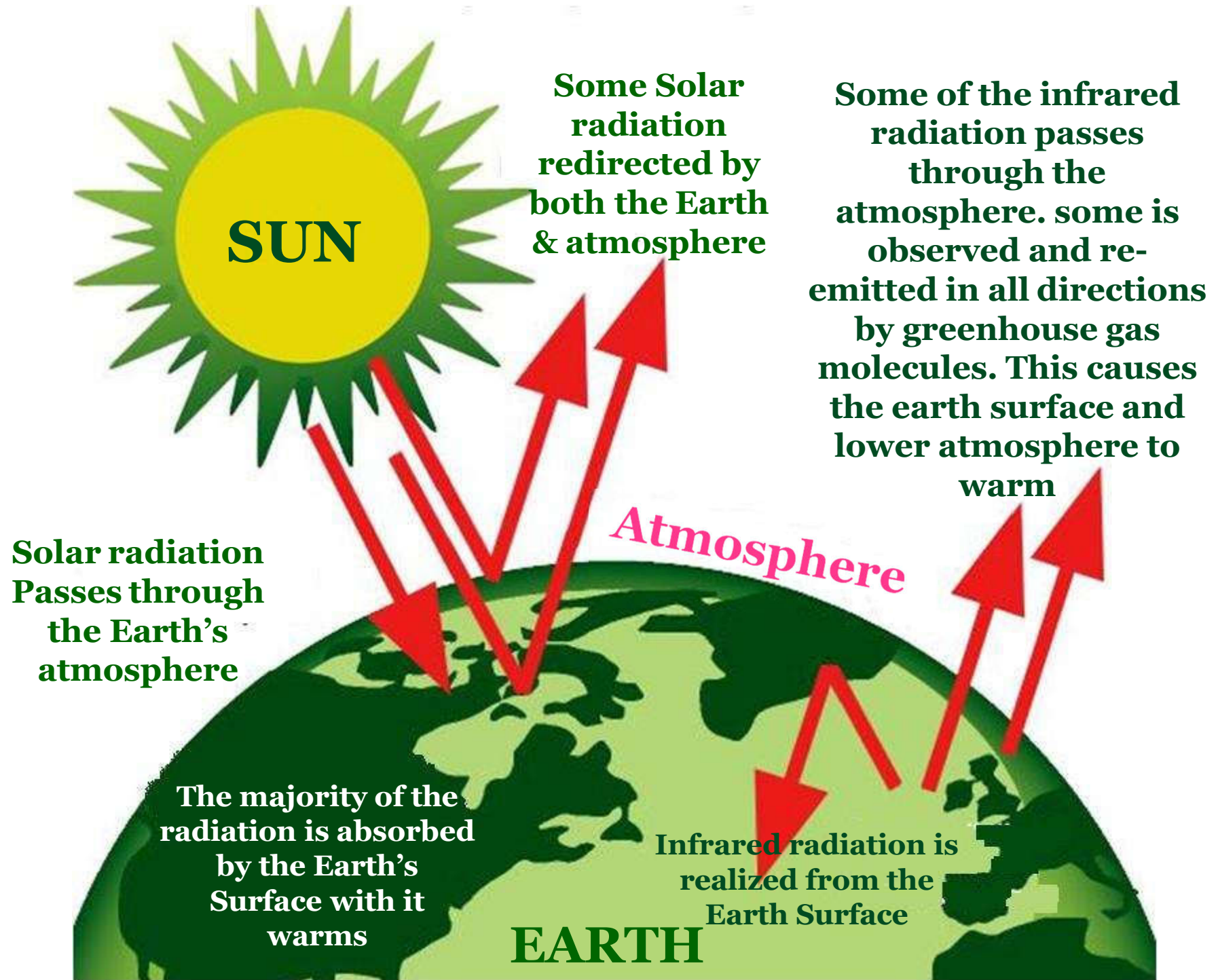
Generated in a variety of industrial processes.

# The Greenhouse Effect on Earth

Earth's atmosphere is slightly warmer than what it should be due to direct solar heating because of a *mild case of greenhouse effect...*

- The ground is heated by visible and (some) infrared light from the Sun.
- The heated surface emits infrared light.
- The majority of Earth's atmosphere ( $N_2$  and  $O_2$ ) are not good greenhouse gas.
- The small amount of greenhouse gases ( $H_2O$ ,  $CO_2$ ) traps (absorb and re-emit) the infrared radiation, increasing the temperature of the atmosphere...







# Greenhouse Gases



## PLANET WATCH

### Recent Highs

**122°F (50°C)**  
**BAHRAIN**  
In a place used to a merciless sun, 56 workers suffer heat exhaustion

**113°F (45°C)**  
**CALIFORNIA**  
Early August heat wave brings blackouts and "spare the air" days to the San Francisco Bay Area

**106°F (41°C)**  
**GERMANY**  
Record hot streak produces severe smog. In some areas, vehicles without antipollution devices are banned

**95°F (35°C)**  
**SWITZERLAND**  
Scorching heat sends kids home from school

**124°F (51°C)**  
**INDIA**  
Worst hot spell in 50 years kills about 3,000 people

**117°F (47°C)**  
**TEXAS**  
A month of 100°-plus temperatures kills more than 120 people and destroys about a third of the cotton crop

**110°F (43°C)**  
**CYPRUS**  
Worst heat wave in 40 years kills at least 55 people and sends 3,200 to hospitals

**100°F (38°C)**  
**FRANCE**  
Sun withers 20% of the grapevines in some areas of Bordeaux

### Global Warming: It's Here ...

Scientists are increasingly convinced that the earth is getting hotter because of the buildup in the atmosphere of carbon dioxide and other gases produced largely by the burning of fossil fuels. For each month this year, average global temperatures have been the highest on record.

**... And almost certain to get worse**

The Intergovernmental Panel on Climate Change, an international group of scientists, projects that the surface temperature of the earth could rise by about 1.8° to 6.3°F (1° to 3.5°C) by 2100. That could have serious consequences:

- In the next 100 years sea levels could rise 1.6 ft. (0.5 m), threatening heavily populated coastal areas from Mississippi to Bangladesh
- Extreme weather events, from hurricanes to droughts, could become more frequent and more severe
- Warmer temperatures could foster crop production in Northern Europe and Canada but dry out important growing regions in the U.S., eastern South America and Southeast Asia
- Tropical diseases like malaria may move northward and southward

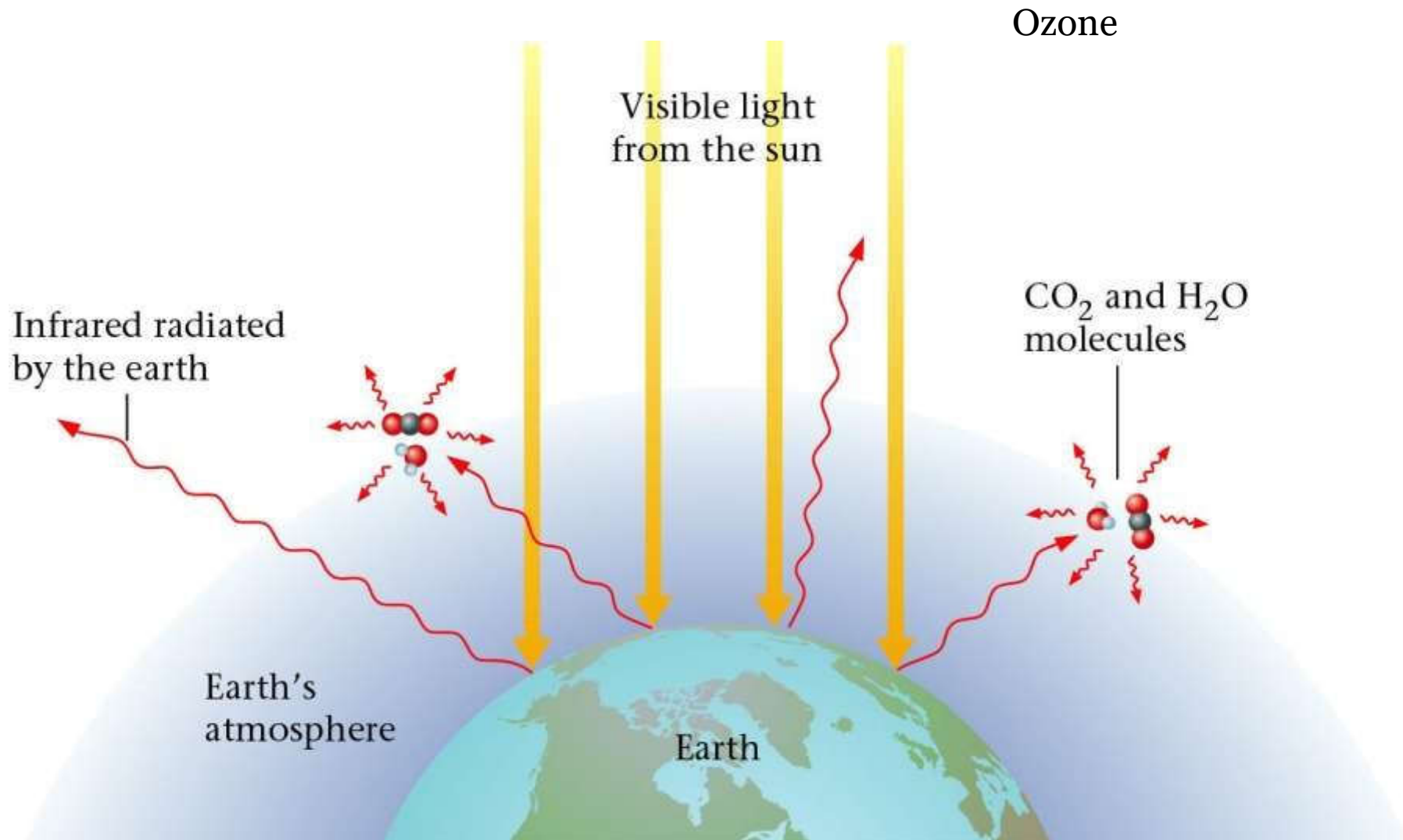
### WHAT YOU CAN DO

Every year about 51 trillion lbs. (23 trillion kg) of carbon dioxide are released into the atmosphere. Here are examples of what you might trim from that total with a few steps:

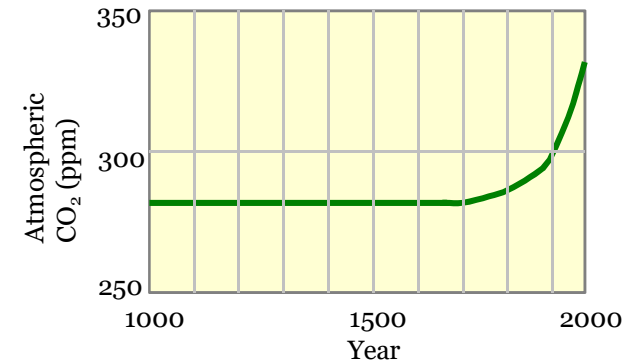
1 Insulate your home .....	2,000 lbs. (900 kg)
2 Install energy-efficient windows .....	10,000 lbs. (4,500 kg)
3 Use compact fluorescent lights .....	500 lbs. (227 kg) for each bulb
4 Run dishwashers full, and clothes washers with warm or cold water .....	700 lbs. (320 kg)
5 Forget the sport utility vehicle and buy a fuel-efficient car .....	2,500 lbs. per extra 10 m.p.g. (1,134 kg per extra 4 km/l)

TIME, AUGUST 24, 1998

# The Earth's Atmosphere



# Greenhouse Effect



➤ **FACT:** 15% increase in [CO<sub>2</sub>] in last 100 years

➤ **Cause:**

- Change from agricultural to industrial lifestyle
- Burning of fossil fuels (petroleum, coal)
- Increase CO<sub>2</sub> emissions (cars, factories etc...)
- Deforestation

➤ **Effects:**

- Global warming
- Melt polar ice caps → flooding at sea level
- Warming oceans → more powerful storms



